

Silica coatings on young Hawaiian basalts: Constraints on formation mechanism from silicon isotopes

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Young basalts from Kilauea, on the big island of Hawai'i, frequently feature visually striking, white, orange and blue coatings, consisting of a 10-50 μm layer of amorphous silica, capped, in some cases, by a ~ 1 μm layer of Fe-Ti oxide [1]. The coatings provide an opportunity to study the early onset of acid-sulfate weathering, a process common to many volcanic environments. Silicon isotopes fractionate with the precipitation of clays and opaline silica, and have been demonstrated to be an indicator of weathering intensity [2,3]. Here we report *in situ* measurements of $\delta^{30}\text{Si}$ of the silica coatings and their implications for coating formation.

The analyzed coated basalt was collected from 1997 overflow lavas at the rim of the Pu'u O'o cone. The sample was mounted in cross section. Analyses were conducted on a Cameca 7f-Geo ion microprobe with a O⁺ primary beam (~ 30 μm spot) and two Faraday cups. The silica coating was measured against the Rose Quartz standard (RSQ). We tested whether the coating's amorphous structure introduced a matrix effect by analyzing quartz and fused glass of the same composition (Ge214). Measurements of those materials were the same within error, so although we have not ruled out other relevant matrix effects (e.g. water content), we accept RSQ as a viable standard for analyzing amorphous silica.

The silica coating was determined to have $\delta^{30}\text{Si} = -1.8 \pm 1.0\text{‰}$ (2 σ). Hawaiian basalts have $\delta^{30}\text{Si} \approx -0.5\text{‰}$ [2], so the silica coatings are $\sim 1\text{‰}$ lighter than the substrate. The sign of this fractionation is consistent with previously reported values for secondary silica [2-4], and implies that, although the silica coatings have a residual/leaching morphology [1], Si was mobile during coating formation. Basalt dissolved in acidic solution, then a fraction of aqueous Si precipitated as amorphous silica; the remaining dissolved Si (tens of percent) was lost from the system. Ongoing work includes confirmation of the SIMS analysis by ICP-MS and replication of observed coating morphologies and isotopic properties in flow-through alteration experiments.

[1] Chemtob *et al.* (2010), *JGR* **115**, 2009JE003473.
[2] Ziegler *et al.* (2005), *GCA* **69**, 4597-4610. [3] Georg *et al.* (2007), *EPSL* **261**, 476-490. [4] Douthitt (1982) *GCA* **46**, 1449-1458.

Origin of the late Mesozoic high-Mg diorites from the North China Craton: Petrological and Os isotopic constraints

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The Mesozoic Tietongou & Jinling high-Mg dioritic plutons from the north China craton contain plagioclase (45-55%), hornblende (20-40%), Cpx (10%) and minor Opx, olivine, biotite, quartz, and accessory sphene, magnetite and apatite. The diorites ($\text{SiO}_2 = 52\text{-}63\%$) show high MgO (9.2-3.5%), Sr (470-980 ppm), Ni (15-157 ppm), Cr (35-416 ppm) and Co (20-35 ppm), with $I_{\text{Sr}} = 0.7052\text{-}0.7083$ and $\epsilon_{\text{Nd}}(t) = -4.5$ to -15 . The contradictory geochemical features of the high Sr and high compatible Ni, Co and Cr are reminiscent of the sanukitoids of late Archean times.

Traditionally, the Tietongou and Jinling high-Mg dioritic plutons were suggested by most workers to have originated from partial melting of the eclogitized Archean mafic lower crust delaminated to mantle depths due to crustal thickening, followed by interaction of the resultant dioritic melts with mantle peridotites during magma ascent, during which the melts gained additional MgO. However, our petrological and Os isotopic data suggest that the dioritic plutons formed from a process of magma mixing between basaltic magma and granitic crustal melt formed due to underplating of the basaltic magma in the lower crust. In this model, no crustal thickening and delamination of the lower mafic crust is required. Main arguments are as below. (1) Plagioclase shows compositional and textural disequilibrium, as revealed by the eroded calcic core (An_{78-60}) surrounded sharply by a mantle with much lower An contents (38-16), which is typical of magma mixing between mafic and felsic magmas. (2) Hornblende shows complex compositional zoning, with low TiO_2 zones (0.8%) surrounded by high TiO_2 zones (2.7%), suggesting an input of high temperature basaltic magma during magma evolution. This agrees with the complicated compositional zoning of Cpx. Opx is always rimmed by Cpx, indicating a reaction relationship. This, along with the presence of millimeter-scale relict aggregates of olivine + Opx, suggests that the dioritic plutons are actually mixture of melts plus xenoliths. (3) The dioritic plutons have Os isotopic ratios in the range 0.33-1.22. If the dioritic plutons were formed by interaction of the melts from the delaminated Archean lower crust with mantle rocks, the required proportions of the latter would be unreasonably high (30-85%). The Os isotopic data can be reasonably explained by our magma mixing model: the majority of the dioritic plutons were basaltic magma from an enriched mantle source, which mixed with subordinate crustal melts (9-35%) in the lower crust.